Interactive Visualization and Exploration of Time-oriented Clinical Data Using a Distributed Temporal-Abstraction Architecture

Yuval Shahar M.D., Ph.D.[1], David Boaz, B.Sc.[1], Gil Tahan[1], Maya Galperin, M.D.[1], Dina Goren-Bar, Ph.D.[1], Herbert Kaizer, M.D., Ph.D.[2], Lawrence V. Basso, M.D.,M.Sc.[2,3], Susana B. Martins, M.D., M.Sc.[4], Mary K. Goldstein, M.D., M.Sc.[2,4]

[1]Medical Informatics Research Center, Department of Information Systems Engineering Ben Gurion University, Beer Sheva, Israel; [2]Stanford University School of Medicine, Stanford, CA; [3]Palo Alto Medical Foundation, CA; [4]Veterans Affairs Heath Care System, Palo Alto, CA

Abstract: *KNAVE-II is a system for visualization and exploration of large amounts of time-oriented clinical data and of multiple levels of clinically meaningful abstractions derivable from these data. KNAVE-II uses a distributed temporal-abstraction architecture that integrates a set of knowledge services, each interacting with a domain-specific knowledge source, a set of data-access services, each interacting with a clinical data source, and a computational service for deriving knowledge-based abstractions of the data.*

Care providers are often overwhelmed by the amount of time-oriented data associated with patient records, such as those of chronic patients. Providing visualization of the data and of their clinically meaningful interpretations (*abstractions*), and a capability to explore both, has multiple benefits for clinical care, research, and quality assessment.

We describe a system for interactive visualization and exploration of time-oriented clinical data that uses a distributed temporal-abstraction mediator (Figure 1). The mediator integrates data services, knowledge services, and a knowledge-based temporal abstraction service[1]. The system extends our work on visualization of time-oriented clinical information[2].

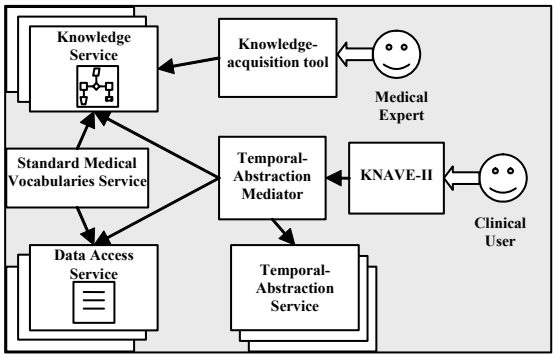

Figure 1. The overall architecture. KNAVE-II enables users to interactively visualize and explore both clinical data and its interpretations, referring all queries to a temporal-abstraction mediator. The mediator integrates the data, knowledge and temporal-abstraction services, indicated by the user, to answer these queries.

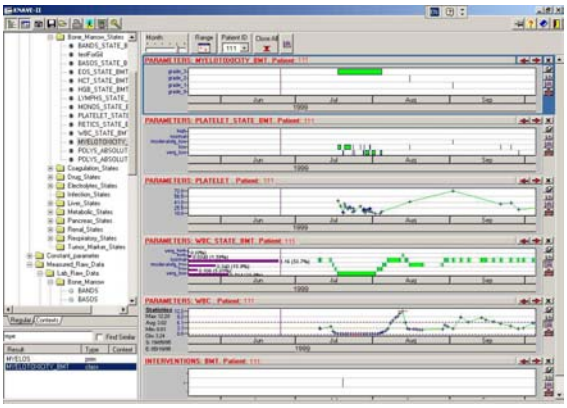

Figure 2: Using KNAVE-II in an oncology domain. On the left is a browser to the domain's *ontology*, derived from the knowledge base. Users select raw data or abstract concepts in the ontology, which are then retrieved or computed on the fly and displayed as panels on the right. Operators (icons in each panel) enable users to perform actions such as explore related concepts, display the knowledge used to derive the concept, and add statistics.

A vocabulary server is used to map data and knowledge terms into standard medical terms. Medical experts maintain the knowledge (Figure 1).

KNAVE-II includes a user-interface module (Figure 2), capable of tasks such zooming in and out of the data, and a computational module interacting with the mediator, which supports tasks such as *semantic exploration* of clinically related concepts. We are currently evaluating KNAVE-II's ability to assist physicians in answering clinical queries.

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References

1. Y. Shahar. A framework for knowledge-based temporal abstraction. *Artificial Intelligence* 90(1–2): 79–133, 1997.

2. Y. Shahar and C. Cheng. Model-Based Visualization of Temporal Abstractions. *Computational Intelligence* 16(2):279-306, 2000.